SCIENCE

NEW SERIES
VOL. LIX, No. 1535

FRIDAY, MAY 30, 1924

ANNUAL SUBSCRIPTION, $6.00
SINGLE COPIES, 15 CTS.

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VOL. LIX MAY 30, 1924 No. 1535

CONTENTS

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. McKeen Cattell and published every Friday by

THE SCIENCE PRESS

Lancaster, Pa. Garrison, N. Y.

New York City: Grand Central Terminal.

Annual Subscription, $6.00. Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

Entered as second-class matter July 18, 1923, at the Post Office at Lancaster, Pa., under the Act of March 3, 1879.

THE PHYSICIST'S PRESENT CONCEPTION OF AN ATOM[1]

ALL scientists agree upon an atom which has a very minute positively charged nucleus surrounded in its outer regions by a number of negative electrons just sufficient to neutralize the free positive charge upon the nucleus.

We all agree that the number of these positive charges upon the nucleus varies from one, in the case of hydrogen, by unit steps up to 92 in the case of uranium, and hence that the number of negatives held in the outer regions also varies from one to 92.

We all agree that the chemical properties of all atoms, and most of the physical properties, too, mass being the chief exception, are determined simply by the number of these electrons; primarily by the number of them which are found in the outermost shell and which we call the valence electrons.

We all agree, too, that the nucleus is extraordinarily minute, so that if all the dimensions of an atom were magnified ten billion times—a magnification which would make a bird shot swell to the size of the earth and would make the diameter of the atom about a meter—the nucleus, on this huge scale of magnification, would not be more than a tenth of a millimeter in diameter—that is, not larger than a mere pin point.

We all agree, too, that in the case of uranium there are packed into that infinitesimal nucleus 238 positive and 146 negative electrons, the exact number of positives being determined simply by the atomic weight, while the number of negatives which bind the positives is the atomic weight minus the atomic number. This obviously means that both positive and negative electrons are so infinitesimally small that for practical purposes we may ignore their dimensions altogether and think of them as mere point charges.

We all agree that so far as physical science has now gone there have appeared but these two fundamental entities, namely, positive and negative electrons[2] which seem to be the building stones of the

[1] An address delivered before the sixty-seventh convention of the American Chemical Society, Washington, D. C., April 22, 1924.

[2] It is highly to be desired that this historically correct, etymologically most suitable, and authoritatively recognized nomenclature (See Rutherford's B.A. address 1923, Nernst's Physical Chemistry, last edition etc., etc.) be retained. When used without a prefix, or qualifying

universe; that these two entities are electrical charges of exactly the same magnitude, but of opposite sign, and that the *mass* or *inertia* associated with the former is 1,845 times that associated with the latter, so that practically the whole mass of the atom is concentrated in the positive electrons within its nucleus.

We all agree that when any of the electrons in the outer regions of the atom are stimulated to radiate, they do so by virtue of falling from a level of higher potential energy to one of lower, *i.e.*, from a level more remote from the nucleus to one nearer to it.

And we all agree that the frequency of the emitted radiations is proportional to the energy loss in the process of changing from the one level to the other. Indeed, one of the most stimulating advances which physicists have made in the past five years consists in the complete demonstration of this Planck-Einstein-Bohr law of radiation. Very recent experiments go even so far as to indicate that this law holds not only for the radiations emitted by the changes in energy levels of the electrons *outside* the nucleus, but also for the radiations which originate in the nucleus itself—the so-called gamma-rays which accompany changes within the nuclei of radioactive atoms.

These results upon which we all agree are proof enough of the amazing advances which have taken place, mostly within the past ten years, in our ability to peer inside the atom and to see what kind of entities exist there and what they are doing when they are in the act of radiating.

The only place where we have differences of opinion, or better, in which there are uncertainties, is in the matter of how the electrons spend their leisure time—the portions of their lives in which they are not radiating.

The chemist has in general been content with what I will call the "loafer" electron theory. He has imagined these electrons sitting around on dry goods boxes at every corner ready to shake hands with, or hold on to, similar electrons in other atoms. The physicist, on the other hand, has preferred to think of them as leading more active lives, playing ring-around-the-rosy, crack-the-whip and other interesting games. In other words, he has pictured them as rotating with enormous speeds *in orbits*, and as occasionally flying out of these orbits for one reason or another.

Now the arguments for the "loafer electron" theory, as I have called it, are two in number. The first is that such activity as the physicist postulates would soon wear away all the energy possessed by the electrons—that is, they would tire themselves out and quit their play.

There is no answer to this argument. They would indeed tire themselves out, provided the classical *electro-magnetic laws are universally applicable*—even in the hearts of atoms. And the physicist's only answer to this argument is, "God did not make electrons that way. Why assume that the electromagnetic laws are universally valid when this is the first chance we have had to test them out in the region of the infinitely small?"

The second argument which has been advanced for the "loafer electron" theory is the existence of localized valences in chemistry. Now, that these localized valences exist is admitted on all hands; but it is simply due to a misunderstanding that this argument was ever used against the orbit theory. *For no physicist—and I wish to emphasize this fact—has ever advanced the theory that the electrons all rotate in coplanar orbits.* Localized valences are just as compatible with the orbit theory when the orbits are properly distributed in space as with the stationary electron conception. All this I pointed out in 1916,[3] trying thereby to clear the misconception which existed in the minds of chemists as to the way in which physicists were thinking.

Let me pass now to the arguments in favor of the orbit theory. They are all of them definite *quantitative* arguments in which purely theoretical considerations lead to exact numerical predictions which can be subjected to the test of experiment.

The first was the exact prediction with the aid of orbit equations of the so-called Rydberg spectroscopic constant which is in agreement, with an accuracy of one part in five hundred, with the directly measured value.

The second quantitative argument comes from the prediction of a difference between the positions in two spectral lines, one due to helium, the other to hydrogen, which two lines should theoretically be one and the same line, if it were not for the fact that the helium nucleus is four times as massive as the hydrogen nucleus.

To make clear the difference which this causes let me ask you to reflect that when an electron revolves around the nucleus of an atom of hydrogen, the real thing that happens is that the two bodies revolve about their common center of gravity, but, since the nucleus is 2,000 times heavier than the electron, this center is exceedingly close to the hydrogen nucleus.

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adjective, the word electron may signify both the generic thing, the unit electrical charge (this it does, in fact, signify both historically and derivatively) and at the same time the negative member of the species, in precisely the way in which the word man is used without a prefix to designate both the genus homo and also the male of the species. There is no gain in convenience by the use of the word proton and a distinct loss logically, etymologically and historically.

[3] *Phys. Rev.*, May, 1917; presented before the American Physical Society, December 1, 1916.

If now the hydrogen nucleus is replaced by the nucleus of the helium atom, which is four times as heavy as that of hydrogen, the common center of gravity is still closer to the nucleus so that the helium nucleus describes a much smaller circle than does the hydrogen nucleus. This situation is responsible for a certain slight but accurately predictable difference in the energies of the two orbits which should cause the lines produced by electron jumps to these two different orbits to be slightly displaced from one another. This displacement is actually found between the corresponding hydrogen and helium lines, and the ratio of the mass of the electron to the mass of the hydrogen atom computed from this displacement agrees with other determinations of this ratio to within a small fraction of a per cent.

The third amazing quantitative success of the orbit theory came when Sommerfeld showed that the Bohr orbit-theory ought to demand two different hydrogen orbits corresponding to the second quantum state, one a circle and one an ellipse. And by applying the relativity theory to the change in mass of the electron with its change in speed, as it moves through the different portions of its orbit, he showed that these two orbits should have slightly different energies, and consequently that both the hydrogen and the helium lines should be doublets.

Now not only is this found to be the fact, but *the measured separation of these two doublet lines agrees precisely with the predicted value,* so that this again constitutes an extraordinary bit of quantitative evidence for the validity of the orbit conceptions underlying the computation.

The fourth quantitative argument was introduced by Epstein when he applied his amazing grasp of orbit theory to the exceedingly difficult problem of computing the perturbations in electron orbits and hence the change in energy of each due to exciting hydrogen and helium atoms to radiate in an electrostatic field. He thus predicted the whole complex character of what we call the Stark effect, showing just how many new lines were to be expected and where each one should fall, and then the spectroscope yielded, in practically every detail, precisely the result which the Epstein theory had foretold.

The fifth quantitative success of the orbit theory is one which Mr. I. S. Bowen and myself at the California Institute have just brought to light. Through creating what we call "hot sparks" in extreme vacuum, we have succeeded in stripping in succession, one, two, three, four, five and six of the valence, or outer, electrons from the atoms studied. In going from lithium through beryllium, boron and carbon to nitrogen, we have thus been able to play with stripped atoms of all these substances. Now the stripped atoms constitute structures which are all exactly alike, save that the fields in which the single electron which is left is describing its orbit increase in the ratios one, two, three, four, five, as we go from stripped lithium to stripped nitrogen. *Now we have applied the relativity doublet formula which, as indicated above, Sommerfeld had developed for the simple nucleus-electron system found in hydrogen and ionized helium, and have found that it not only predicts everywhere the observed doublet separation of the spectra produced by all these stripped atoms, but that it enables us to compute the effect which the two electrons close to the nucleus of all these atoms have in screening the outer rotating electron from this nucleus.*

At a sufficient distance from the nucleus these two electrons ought to neutralize exactly two of the free positive charges on the nucleus, *provided, and only provided, the forces emanating from these electrons fall off with the inverse square of the distance.* Our relativity doublet formula, with this assumption and without the introduction of any arbitrary constants whatsoever, enabled us to predict what the screening effect due to those two electrons ought to be. *And now our experiments on doublet-separations reveal that* that screening is exactly two, which checks with what we knew beforehand, from radioactive and chemical data, that it must be. In other words, we have another method, based definitely upon the theory of the change of the mass of the electron with speed in the different portions of its orbit, which enables us with certainty to look inside the atom and find how many electrons are in the inmost shell, and the answer comes out two.

Again, when we examine the spectrum due to the stripped atoms of the group of atoms from sodium to sulfur—one electron having been knocked off from sodium, two from magnesium, three from aluminium, four from silicon, five from phosphorus, and six from sulfur—we should find in every case that the number of screening electrons in the two inmost shells, when tested for sufficiently remote orbits, comes out two plus eight, *i.e.,* ten. *And it does come out in every case precisely* as predicted. *This constitutes unambiguous proof that the electrons themselves do possess Coulomb fields (fields falling off with the inverse square of the distance),* a result entirely incompatible with the loafer-electron theory. The physicist has thus piled Ossa on Pelion in his *quantitative* proof of the existence of these electron orbits.

These new results are, however, incompatible with the precise shapes of orbits with which the physicists have been working in the field of optics during the last five years. They necessitate either the abandonment of the relativity cause for the separation of our measured spectroscopic-doublets or else they require us to cease to play with a nucleus about which the

electron orbits are largely symmetrical. In other words, if we retain the relativity explanation of the spectroscopic-doublet formula, we are obliged to suppose that two orbits which have the same shape but different orientations with respect to the nucleus may exhibit widely different screening constants—which is only another way of saying that these orbits may possess widely different energies.

To this extent, then, I am able to help out the chemist in his attack upon the electronic orbits of the physicists. I am able to enable him to say with a good deal of certainty that these orbits can not be of precisely the type which we physicists have been playing with so assiduously for the past five years. If we retain the explanation which has heretofore been given to the relativity doublet formula, an explanation which requires entirely different shapes for the two orbits corresponding to these doublets, then we must begin to work with an atom which is very much less symmetrical with respect to the differently oriented orbits than we have hitherto been imagining.

R. A. Millikan
Norman Bridge Laboratory of Physics

REMARKS ON THE SCIENTIFIC ATTITUDE[1]

If all our farmers were acquainted with the discoveries made by agricultural experts and were willing to adopt methods recommended by these experts the agriculture of this country and of the world would be far in advance of what it is. If all people were acquainted with the laws of health and hygiene and with the knowledge of these subjects possessed by our best investigators in preventive medicine and were willing to follow expert advice the average life would be greatly prolonged. Social progress is made possible through the activities of the few who are far in advance of the masses. The masses, at least in the more civilized countries, accept the material benefits conferred through the activities of the few. There is little hesitancy in adopting the telephone, the radio and the automobile. But in the realm of spiritual things, society lags. There is mental inertia, just as there is physical inertia. How reluctant have been the masses to accept the theory of evolution! The reason for this difference between the masses and the advanced thinkers must be sought in the mental attitude. Let us, then, examine the mental qualities of the scientist, who is an advanced thinker in physical progress, with the assurance that much the same qualities must be possessed by leaders of thought in all branches of social progress.

The scientist searches for truth. He seeks to establish facts. He combines facts, works out their relation, modifies existing theories or systems to accord with increased knowledge. The ideal mental condition of the scientist is known as the scientific attitude. It is open-mindedness in the sense that new ideas are received on their merits and are not discounted in advance by prejudice and preconceived notions.

All here in my audience know what is meant by this term, the scientific attitude. Probably none of us possess this attitude in its ideal completeness. It is a state of perfection toward which we strive but probably never quite reach. The reasons for this imperfect attainment lie in our phylogenetic history.

Man as a social animal is controlled very profoundly by inherited tendencies—instinct it is called among the lower animals. Society also is controlled by inherited tendencies, that is, tradition and custom. In accord with these influences man has tended to be conservative and society has tended to be static. As a unit of society man is and always has been influenced by the mental attitude of the mass, which is that what is, is right. The constructive leader in progress is an individual who is mentally what the horticulturist would call a sport, he must diverge sharply from the average. In so far as he wishes to develop or modify social, political, economic or religious customs or beliefs he comes in contact with the static condition of the masses who think and act in accord with inherited tendencies.

Again, what is the usual ontogenetic history of the individual? From the moment that a child is born it is subjected to the will of others. With few exceptions it is taught to think as do its parents, to obey authority. In school the same kind of influence continues. A good boy is one who obeys his teacher, one who respects authority. In society the youth is taught to look up to his elders, to his superiors, to his boss. Parental discipline, school discipline, organization discipline, on the average and in the main tend to stifle independent thought. In this I am not intending to decry parental authority or school discipline, but to point out that the usual environment in which we grow up does not tend to develop the scientific attitude.

In attaining a condition of open-mindedness we are overcoming our inherited tendencies and the effects of our childhood and our present-day environment, and very few of us are able to do this completely.

There is conservatism in science as in other branches of human knowledge. An accepted theory in chemistry, geology or biology becomes in a sense a tradition, and facts tending to disprove such a theory are not infrequently viewed with a hostile eye by its supporters.

[1] From the address of the retiring president of the Biological Society of Washington. There were three parts: (a) Remarks on the scientific attitude; (b) botanizing in Ecuador; (c) how to help the Biological Society.

The individual may be open-minded to the work of others but be very conservative when considering facts which tend to upset his own published conclusions.

Of course open-mindedness can be carried to an extreme. To be open-minded does not mean to accept all statements with equal freedom. That would be credulity and not open-mindedness in the sense of the scientific attitude. The scientist does not receive the statement that the earth is flat by saying: "That may be so; some say it is round. I will look into the matter."

I now wish to speak of a not infrequent tendency among scientists against which we all need to struggle. We may retain the scientific attitude in our specialty or in science in general but lose this attitude when we approach such subjects as politics, religion or business. During the recent war there were people who under the influence of war hysteria hated everything German, even German music, and belittled the achievements of German science—an attitude scarcely to be called unprejudiced. Can we say that all scientists were free from this feeling? Since the war many people, good and true, fearful for the foundation of things as they are, have been stampeded into condemning others because they were said to hold radical views and, Heaven protect us! they even might be Bolshevists. This, though these good people might not know what a Bolshevist was—the word was enough, it sounded bad. Can we say that all scientists were entirely free from this feeling—this unreasoning mass action?

Clear thinkers are responsible for social progress. Scientists are well in the van among leaders of the world's thought. But we are of the people. We are not separated as a class phylogenetically. We are not moving in a definite direction by means of physical evolutionary processes, as is the Morgan horse or the collie dog. Our ranks are being ever added to from the mass of the species. The roots of our lives lie in the prejudices of the past. From this standpoint one may well express surprise that so many have disentangled themselves from the past and have progressed so far toward the ideal of absolute open-mindedness. These links with our common heritage have been largely severed by scientists so far as concerns their own special field. But in other fields the links may still hold us. We require verification concerning statements of scientific facts; but we may accept without hesitation the most unverified statements about the League of Nations or German reparations. Propaganda could make no headway were statements met with scientific inquiry.

Finally, I believe strongly that scientists as a class should carry their scientific attitude into the realms of affairs outside the world of science. The scientific method of thought has been applied chiefly in a material way and not sufficiently toward the solution of economic problems. It is absurd for a scientist to shiver with fear if he sees a black cat cross his path or if he walks under a ladder. It is equally absurd to believe that all Germans or all democrats, or all Roman Catholics or all I. W. W.'s, or all the members of any social, political or religious class are undesirables and a menace to society. Why should we hesitate to apply scientific methods of thought to the tariff, to ship subsidy, to birth-control, to the recognition of Russia, to the ancient custom of marriage, to the Centralia trials, to the Ku Klux Klan and to a thousand other subjects upon some of which we may have formed opinions based upon unverified statements, thus often being the victims of systematic propaganda? Until we can do this we have not attained freedom; until then our ancestors are reaching up from the oblivion of the past to direct our course.

A. S. HITCHCOCK
U. S. DEPARTMENT OF AGRICULTURE

UNIVERSITIES AND LEARNED SOCIETIES

IT is with gratitude that we of the universities return once a year to this ancient society, and we depart again with confidence renewed. Here, but seldom elsewhere in our country, we find an unchanging devotion to the truth for its own sake, and a simple conviction, such as a plain man may grasp, of the *value* of truth. This is a society which has and feels no need to advertise its wares, and thereby to cheapen them, which happily escapes the tendency that is turning our institutions into mechanisms, which still believes in the individual, and does *not* believe in committees and councils of the elect.

These rare and surpassing merits of the Philosophical Society perhaps are, and have been, more the result of good fortune than of deliberation. They are due to detachment, to a failure to cooperate in setting up visionary projects which are not adapted to the nature of man; in short, to a blessed inactivity on the part of the society and to a corresponding free activity on the part of the members.

How uncommon elsewhere are these old-fashioned virtues! The colleges and universities, their equilibrium disturbed by the addition of vast schools of journalism and of pedagogy, of summer schools, evening schools and correspondence schools, move on with the civilization which they serve into a future that we can not prophesy. This is as it should be. But the change is painful, it is often directed by ignorance, and it leads to the worship of many strange new gods.

[1] Speech at the annual dinner of the American Philosophical Society, Philadelphia, April 26.

Too often the universities have taken over from the world of affairs a conception of useful knowledge and a concept of usefulness that would have chilled the heart and stirred the indignation of Franklin. Practical men, it has been said, are those who practice the errors of their forefathers.

But this society remains true to Franklin's tradition. He knew, and we do not forget, what Sadi Carnot's reflections on the motive power of heat and Pasteur's studies of wine making, of anthrax and of rabies illustrate, that there is common ground for the theoretical and the practical, just because the most abstract knowledge is the most general, and thus the most useful, and again because what is important often owes this to the operation of an important principle.

Let this pass. It is not the changes in the universities, it is the national organization of science through national societies, councils and committees that one holds in smallest esteem to-day—this, and the dependence of such organization upon money, upon money provided in the expectation of a return and in the hope, occasionally, of a disproportionately great return.

There has grown up in America as a legacy of the war an activity that is administrative, an administration that is bureaucratic, a bureaucracy that is unconsciously guided by any consideration but that of the true interest of science, or, in the proper sense, of true usefulness.

The men of science of America, in their corporate capacity, happily only not through this society, now find themselves allied and almost in partnership with industry and business for the study of such questions as the place of sandwiches in the diet; they have been won for the support of the researches of the Baby Goose Society and are about to consider an alliance with the National Selected Morticians.

From this state of affairs escape will be difficult. The fact is that a mechanism, excellent for some purposes, and conceived with the highest motives, has all but taken control of the men whom it should serve. Such a mechanism can not be actuated by the forces which actuate true science, but in spite of every difficulty it *must* be controlled by them.

To its honor and glory our society has had nothing to do in bringing about this disgraceful and ridiculous condition. May it, by continuing to cultivate its garden, contribute to the cure of that which it has not caused.

LAWRENCE J. HENDERSON

THE BRITISH ASSOCIATION AND THE TORONTO MEETING

The British Association for the Advancement of Science, which was founded in 1831, meets annually for one week or longer at important centers, other than London, England, and it occasionally meets in other parts of the British Empire. The association has met in Canada on three previous occasions, *viz.*, in 1884, 1897 and 1909. Other overseas meetings have been held once each in South Africa, 1905, and Australia, 1914.

The average attendance at annual meetings of the association for the 83 years previous to 1920 was 2,330. A proportion of the attendance consists always of residents in the locality where the meeting is held, but the large proportion are visitors. The Toronto meeting affords an exceptional opportunity for intercourse between British, Canadian, American and European workers in science.

A preliminary program will be forwarded on application to the local secretary, British Association, Physics Building, University, Toronto, and those who intend to be present at the meeting are particularly requested to apply for this as soon as possible.

No technical qualification is required on the part of an applicant for admission as a member of the association, nor is there any limitation in respect of nationality. The form of membership of most interest to Americans and Canadians, who are very cordially invited to join for 1924, is that of annual member.

Payment of $7.50 made before or at the meeting entitles the annual member to attend the meeting and to receive the report. Payment of $5.00 entitles the member to attend the annual meeting and the membership ticket admits the holder to any of the sectional meetings and to the various popular lectures, receptions, local excursions, etc., which are features of the meeting.

Membership tickets for the meeting may be obtained from the local Honorable Treasurer, British Association, Room 50, Physics Building, University, Toronto; cheques should be made payable to the British Association for the Advancement of Science.

Arrangements are being made with the railway companies for reduced rates on the return fares of those who hold membership cards. Hotel accommodation should be reserved in advance of the date of the meeting.

SCIENTIFIC MEETINGS

The inaugural general meeting will be held on Wednesday, August 6, when Major-General Sir David Bruce, K.C.B., F.R.S., will assume the presidency in succession to Professor Sir Ernest Rutherford, F.R.S., and will deliver the presidential address.

The association is organized in thirteen sections with presidents for 1924 as follows:

A. Mathematical and Physical Science: Sir Wm. Bragg, K. B. E., F. R. S.

B. Chemistry: Sir Robert Robertson, K.B.E.
C. Geology: Professor W. W. Watts, F.R.S.
D. Zoology: Professor G. Elliott Smith, F.R.S.
E. Geography: Professor J. W. Gregory, F.R.S.
F. Economic Science and Statistics: Sir William Ashley.
G. Engineering: Professor G. W. O. Howe.
H. Anthropology: Dr. F. C. S. Shrubsall.
I. Physiology: Dr. H. H. Dale, C.B.E., F.R.S.
J. Psychology: Professor W. McDougall, F.R.S.
K. Botany: Professor V. H. Blackman, F.R.S.
L. Educational Science: Principal Ernest Barker.
M. Agriculture: Sir John Russell, F.R.S.

Addresses will be delivered by the sectional presidents of the respective sections and papers will be read on and after Thursday, August 7, until the conclusion of the meeting.

Joint meetings of various sections will be held also at which the following are among the subjects to be discussed:

A and B Crystal Structure and Colloid Solutions.
A and G Optical Study of Elasticity.
B and I Vitamines and the Relation of Light to their Action.
B and G Liquid and Powdered Fuels.
C and E Changes of Sea-level in relation to Gravitation, Continental Shelves and Coral Islands.
I and J Physiological and Psychological Factors of Muscular Efficiency in Industry.
D and K Species Concept.
D and M Soil Population.
J and L Tests for Scholarship and Promotion.
F and M Diminishing Returns in Agriculture.
H and J Racial Mental Differences.

During the week of the meetings a number of popular lectures will be delivered by prominent visitors. Among the titles which have been announced are:

Human Heredity and National (or racial) outlook: Professor W. McDougall, M.B., F.R.S.

Seeing is believing: Professor E. P. Cathcart, M.D., F.R.S.

Work in the Himalayas: Professor J. W. Gregory, D.Sc., F.R.S.

Voice Production: Sir Richard Paget.

Disintegration of Atoms: Sir E. Rutherford, F.R.S.

The Importance of the Infinitely Small in Nutrition: Professor J. C. Drummond, D.Sc.

A lecture to the Workers Educational Association will be delivered by Professor R. H. Tawney, of Oxford University.

The subject of the presidential address by Sir David Bruce will be "Advances made in our knowledge of disease (with special reference to methods developed during the war)."

Additional information will be gladly supplied by the Local Secretary, British Association, Room 50, Physics Building, University, Toronto, Canada.

SCIENTIFIC EVENTS

THE BIOCHEMICAL LABORATORIES OF THE UNIVERSITY OF CAMBRIDGE

THE new building of the biochemical laboratories were formally passed over to the Earl of Balfour, chancellor of the university, by Sir Jeremiah Colman on May 9.

The laboratories, which are situated opposite Pembroke College, have been made possible by the decision of the trustees of the will of Sir William Dunn, a city merchant, who died in 1908, to devote to biochemistry the residue of the estate, which was left with instructions that it was to be used for the "alleviation of human suffering." The sum of £210,000 was allocated to this purpose. The actual building, designed by Sir Edwin Cooper, has cost about £96,000. Besides a spacious general laboratory at the top of the three-story structure, there are about twenty rooms, fully equipped on most modern lines for research. There is a large library, for the endowment of which Sir Jeremiah Colman, chairman of the trustees, has presented £2,000.

The British Medical Journal writes:

At the present moment the building contains no fewer than thirty-six people engaged on research, a number which it may be necessary to diminish in view of the limited space and funds available. The largest group of workers, under the general direction of Professor F. Gowland Hopkins, are dealing with oxidation processes both *in vivo* and *in vitro*. . . . Four workers are examining bacterial metabolism by exact quantitative methods similar to those which are used on larger organisms. Several workers are dealing with carbohydrate metabolism from different standpoints. Others are dealing with the synthesis of various sulphur compounds in the animal body, and with the remoter effects on human metabolism of changes in the hydrogen-ion concentration of the tissues.

Besides four plant biochemists, who are mainly concerned with oxidases, individual workers are dealing with problems which range rfom inositol metabolism and the sulphur content of diseased crabs, to the structure of the haemoglobin, casein and thyroxin molecules. Some hitherto neglected aspects of the vitamin question are being dealt with, and a start is being made on cancer research.

The present research community includes three Australians, a Canadian, a New Zealander, an Irishman, an Indian, an American and a Norwegian, while last year Switzerland was represented. Eleven of the researchers are women. Six—namely, Professor Hopkins, Dr. Hele, and Messrs. Cole, Haldane, Roughton

and Dixon—hold university posts. Of the others four are Beit fellows, two are 1851 Exhibition scholars, and one a Ramsay memorial fellow. Most of the remainder are in receipt of grants from the Medical Research Council or the Department of Scientific and Industrial Research.

THE RUSH MEDICAL COLLEGE AND THE UNIVERSITY OF CHICAGO

PLANS for the merging of Rush Medical College with the University of Chicago have been completed. Medical work will be organized as follows:

1. The Rush Medical College of the university, which will continue its work as formerly at present, will prepare students for the M.D. degree on its old site on the West Side.

2. The Rush Post-Graduate School of Medicine will be housed with the Rush Medical College in the New Rawson Laboratory on the West Side and will train graduate physicians.

3. The School of Medicine of the University of Chicago will be housed in the new medical buildings and will prepare students for the M.D. degree and higher research. This is now being organized by Dr. Franklin C. McLean and Dr. Dean D. Lewis. When this school is in full operation, it is expected that it will absorb the work of Rush Medical College and the two permanent institutions will be the Rush Post-Graduate School on the West Side and the School of Medicine of the University of Chicago on the Midway.

The new Rawson laboratories, to be erected at a cost of $400,000, will house the graduate department of the school and will be erected on the ground now occupied by the old Rush Medical College building. This building will house the administration offices of the college, the medical library, the departments of occupational therapy, hydrotherapy, pathology and the free dispensary. The Norman Bridge Laboratories of Pathology will occupy the fifth floor. The West Side departments will then include Senn Hall, a research laboratory, and affiliated institutions, including the Presbyterian Hospital, the John McCormick Memorial Institute for Infectious Diseases and the Home for Destitute Crippled Children. The units to be erected at once include the Albert Merritt Billings Memorial Hospital of 200 beds, and the physiologic group. The Billings family donated $1,000,000 for the hospital and Mr. and Mrs. Max Epstein, $100,000 for the Epstein Dispensary. The hospital will house the Billings Library, a gift of Dr. Frank Billings. The new medical buildings for the graduate school of medicine will cost more than $3,000,000. All the new structures will be in Gothic architecture to correspond with the other buildings of the university.

Dr. Ernest E. Irons, professor of clinical medicine at Rush Medical College, who has been acting dean of students, has been appointed dean of Rush Medical College of the University of Chicago. Dr. Frank Billings, who has been dean of the faculty for the last twenty-five years, has resigned. The two positions, dean of the students and dean of the faculty, have been combined.

THE SEMI-CENTENNIAL OF PURDUE UNIVERSITY

THE semi-centennial of the founding of Purdue University was commemorated at Lafayette, Indiana, with an elaborate program during the first three days of May. At the opening session addresses were given by Edward A. Birge, president of the University of Wisconsin, on "The land grant college and the state"; by Miss Isabel Bevier, professor emeritus of the University of Illinois, on "Home economics in education," and by Henry Suzzallo, president of the University of Washington, on "The probable trends in higher education." On the following day the exercises were preceded by an academic procession. After the more than 200 delegates present, representing educational institutions, learned societies, technical associations, industrial organizations and the Purdue alumni, had been presented to President Edward C. Elliott, an address on "Educational objectives in the modern college" was delivered by Dr. William O. Thompson, president of the Ohio State University. At a notable conference on technical education addresses were given by Dr. Robert A. Millikan, of the California Institute of Technology; by Dean Dexter S. Kimball, of Cornell University, and by President Reynolds of the Ontario Agricultural College. At the closing session, which was preceded by a student procession, President Elliott spoke on "The pursuit of power," and responses were made by representatives from the alumni, by the class of 1924 and by the Board of Trustees. Other addresses were given at the formal of one dollar to the Secretary-Treasurer has been

FELLOWSHIPS IN MEDICINE OF THE NATIONAL RESEARCH COUNCIL

THE Medical Fellowship Board of the National Research Council had its regular semi-annual meeting on April 26, 1924, and continued the appointment of the following fellows, in some instances with a change of location of their work:

NAME	PLACE OF WORK	SPECIALTY
Albritton, Errett C.	Ohio State	Physiology
Andrus, E. C.	Vienna	Physiology
Andrus, W. D.	Cincinnati	Surgery
Anson, Barry J.	Harvard	Anatomy
Cone, W. V.	Columbia	Neuropathology
Kleitman, Nathaniel	Paris & Chicago	Physiology
Leonard, C. S.	Yale	Pharmacology

NAME	PLACE OF WORK	SPECIALTY
McCordock, H. A.	Johns Hopkins	Pathology
Newman, L. H.	Harvard	Biochemistry
Sands, M. J.	Cambridge	Physiology
Smith, Francis M.	Johns Hopkins	Biochemistry
Smith, Homer W.	Harvard	Physiology

From a list of 52 candidates the following 14 were appointed:

Britton, Sydney W.	Harvard	Physiology
Chambers, Wm. H.	Cornell	Physiology
Drabkin, David L.	Yale	Biochemistry
Hughes, Thomas P.	Harvard	Bacteriology
Isaacs, Moses L.	Columbia	Biochemistry & Immunity
Katz, Louis N.	London	Physiology
Kennedy, James A.	Harvard	Bacteriology
Loebel, Robert O.	Berlin	Physiology
McKinley, Earl B.	Brussels	Bacteriology
Miller, Aura J.	Harvard	Pathology
Reed, Carlos I.	Chicago	Physiology
Scriver, W. DeM.	Harvard	Biochemistry
Shambaugh, Noel F.	Michigan	Biochemistry
Woodall, Chas. S.	Harvard	Biochemistry

The following general action as to the administration of the fellowships was also taken: A limited number of appointments to work abroad will be made, selections to be made because of special qualifications and upon the initiative of the board, not the candidate. Applicants may express a desire to work in a foreign country, but should also indicate with whom they would desire to work in this country if not accepted for work abroad.

THE ALABAMA ACADEMY OF SCIENCE

ON April 4, there was organized at Montgomery, Alabama, an Alabama Academy of Science with the following officers elected:

President, Wright A. Gardner, Ph.D., head of the department of botany, Alabama Polytechnic Institute.

First Vice-president, H. D. Pallister, Ph.D., head of the School of Mines, University of Alabama.

Second Vice-president, Walter C. Jones, M.D., professor of zoology in the Birmingham-Southern College.

Secretary-Treasurer, Sumner A. Ives, Ph.D., head of the department of biology of Howard College.

Honorary Dean, Eugene A. Smith, Ph.D., state geologist, University of Alabama.

There were fifty-six members present and seventeen papers presented. The object of the organization is to promote scientific research. The opportunity to become a charter member by paying the annual dues of one dollar to the Secretary-Treasurer has been extended to June 4.

SUMNER A. IVES,
Secretary-Treasurer

SCIENTIFIC NOTES AND NEWS

THE University of Manchester conferred at the Founder's Day ceremony on May 21 its honorary doctorate of science on Professor Niels Bohr and Professor Max Weber.

SIR EDWARD SHARPEY SCHAFER, professor of physiology in the University of Edinburgh, has been elected a corresponding member of the French Academy of Medicine.

DR. FRANZ BOAS, professor of anthropology in Columbia University, has been elected a corresponding member of the Bavarian Academy of Sciences.

GOVERNOR SMITH has reappointed Dr. Simon Flexner as a member of the New York State Public Health Council for a term of six years.

DR. HENRY M. HURD, psychiatrist and physician, and first superintendent of the Johns Hopkins Hospital, celebrated his eighty-first birthday on May 3.

THE Victorian Medal of the Royal Geographical Society was on May 26 handed to Boylston Beal, special United States Embassy attaché for Dr. John F. Hayford, director of the College of Engineering of Northwestern University to whom it was recently awarded for conspicuous merit in scientific research in geography.

PROFESSOR C. J. KEYSER and Professor Edward Kasner have been designated delegates from Columbia University to the International Mathematical Congress to be held in Toronto in August. Dr. Frederick Hollister Safford will be delegate from the University of Pennsylvania.

DR. FRANCIS GILMAN BLAKE, of the Yale Medical School, has been elected a member of the Board of Scientific Directors of the Rockefeller Institute for Medical Research, to fill the vacancy created by the death of Dr. Hermann M. Biggs.

AT the meeting of the Association of American Physicians at Atlantic City, N. J., early in May, lectureship prizes were awarded to Dr. George F. Dick, of Chicago, and Dr. Alphonse R. Dochez, of New York, for their work in connection with scarlet fever.

PROFESSOR S. KITASATO, director of the Biological Institute at Tokio, whose name is particularly associated with the discovery of the bacillus of plague, has been created a baron by the Emperor of Japan in recognition of his scientific services. He is the first member of the medical profession unconnected with the government to be so honored. Baron Kitasato will be president of the sixth congress of the Far Eastern Association of Tropical Medicine to be held in Japan next October.

DR. R. E. STRADLING, head of the department of civil engineering, architecture and building in the Technical College, Bradford, since 1922, has been appointed director of research of the Building Materials and Construction Research Board of the Government Department of Scientific and Industrial Research.

DR. LEWIS A. CONNER, of New York, was elected president of the Association of American Physicians, at the annual meeting held in Atlantic City, on May 6 and 7. Dr. Richard P. Strong, professor of Tropical Medicine at the Harvard Medical School, was elected vice-president.

PROFESSOR MARY W. CALKINS, of the department of philosophy and psychology at Wellesley College, has been elected vice-president of the American Association of University Professors. She will fill the vacancy caused by the death of Professor M. S. Slaughter, of the University of Wisconsin.

DR. F. E. BREITHUT, who has for the last year been in Europe as trade commissioner, with special reference to the chemical industries, of the New York City Department of Commerce, has resigned in order to resume his work in the department of chemistry of the College of the City of New York.

WILLIS T. LEE has been granted leave of absence for the rest of the year from the Geological Survey and will make a detailed study of the Carlsbad Cave in Arizona for the National Geographic Society.

DR. E. V. COWDRY, of the Rockefeller Institute for Medical Research, sailed recently for South Africa *via* England to spend, at the invitation of the dean of the veterinary division, Sir Arnold Theiler, a year at the Transvaal University College in Pretoria, where he plans to study the life cycle of protozoa causing diseases of domestic animals.

DR. ROBERT W. HEGNER and Dr. Francis M. Root, of the department of medical zoology of the School of Hygiene and Public Health of the Johns Hopkins University, sailed on May 31 for a summer in tropical America, where they will work in cooperation with the medical department of the United Fruit Company. They will visit Cuba, Jamaica, Guatemala, Honduras, Panama and Colombia, remaining a sufficient length of time at Tela, Honduras and Santa Marta, Colombia, to carry on investigations on malaria, mosquitoes and intestinal protozoa. During the latter part of July they will attend the International Congress on Health Problems in the Tropics at Kingston, Jamaica.

DR. ALEXANDER HAMILTON RICE, vice-president of the American Geographic Society, has organized an expedition for scientific study in Central Brazil during the coming year, and has invited Dr. Richard P. Strong, director of the Department of Tropical Medicine at Harvard University, to conduct a medical expedition in this same region for purposes of scientific investigation. Other members included in the medical expedition will be Dr. George C. Shattuck, Dr. Joseph Bequaert and Mr. Ralph Wheeler.

CAPTAIN G. H. WILKINS, formerly biologist of the *Quest* expedition, who has been collecting specimens in Australia for the British Museum, proposes to lead a small expedition to the Antarctic next year to investigate the possibility of using airplanes in connection with a search for sites for establishment of meteorological stations.

DR. LEON J. COLE, chief of the Division of Animal Husbandry of the Department of Agriculture, and Mr. Edward N. Wentworth, director of Armour's Livestock Bureau, Chicago, have been invited as the guests of honor of the Scottish Cattle Breeders' Conference, to deliver a series of lectures on the genetics of cattle breeding, from July 7 to July 11 inclusive. The conference will be held at Edinburgh this summer in connection with the gathering of breeders and scientific workers from the colonies at the British Imperial Exhibition. While abroad, Dr. Cole and Mr. Wentworth will spend some time studying Danish pig-breeding and methods of bacon production.

PROFESSOR JULIUS STIEGLITZ, of the University of Chicago, delivered, on May 12, 13 and 14, the second course of Dohme Lectures at the Johns Hopkins Medical School on "Chemistry and recent progress in medicine." The lecturer presented his subject from the point of preparative chemistry and physical chemistry and also considered the question of oxidation in the animal body from a physical chemical standpoint. The lectures will be published in the Johns Hopkins Hospital Bulletin and in the form of a brochure.

THE meeting of the Philosophical Society of Washington on May 31 will be addressed by Dr. Alfred J. Lotka, of the Johns Hopkins University, on "Irreversibility—cosmic and microcosmic."

DR. LEE DEFOREST delivered a lecture on "Talking movies," under the auspices of the Yale Branch of the American Institute of Electrical Engineers, on May 7.

A BUST of Admiral George Melville, by Samuel Murray, has been bought for the American Society of Mechanical Engineers by a group of his personal friends. The committee in charge of the purchase and presentation of the bust is composed of Alexander C. Humphreys, Asa M. Mattice, Ira N. Hollis, Robert S. Griffin, William D. Hoxie and Walter M. McFarland. The formal presentation will probably be made some time during the annual meeting of the society

next December. Admiral Melville, former engineer-in-chief of the U. S. Navy, was president of the society in 1899 and an honorary member at the time of his death in 1912.

DR. ROBERT G. HALL, to whom his father, the late Dr. Stanley G. Hall, ex-president of Clark University, left his library, together with other household goods, has presented to the department of psychology of the university the library and a number of the pictures which hung in the room in which Dr. Hall for years held his Monday evening seminar. It is planned to keep the collection together and to reconstruct, in so far as this is possible, the setting of the familiar seminar room.

PROFESSOR J. H. TEACHER has presented to the University of Glasgow for the new common rooms a fireplace from the Lister Ward, which he has acquired from the demolition contractor. The gift includes an iron grate of simple type with curved bars, an ash-pan, a steel fender and a plain grey stone mantelpiece.

A SPECIAL feature of the celebration of the two hundredth anniversary of the birth of Immanuel Kant, in Königsberg, on April 22, 1724, will be the presentation of money and books to the university, where he was appointed professor of philosophy in 1770.

DR. EUGENE WARMING, emeritus professor of botany at the University of Copenhagen, died on April 2, aged eighty-three years.

M. C. A. ANGOT, director of the Central Meteorological Bureau, Paris, died on March 16, aged seventy-five years.

DR. V. HENSEN, emeritus professor of physiology in the University of Kiel, has died at the age of eighty-nine years.

AT the request of the commission on new types of examination of the College Entrance Examination Board, Professor L. P. Eisenhart, of Princeton University, has formed a committee of mathematicians to examine critically certain statistical methods used in the investigations of the commission. The other members of the committee are Professors R. W. Burgess, W. L. Crum, E. V. Huntington, H. H. Mitchell, H. L. Rietz and J. H. M. Wedderburn.

AT the Conference of Industrial Hygiene to be held in Geneva in July, discussions have been announced as follows: The subject of "Vitiated atmosphere in workshops" will be introduced by Professor Leonard Hill, who will deal with ventilation. Dr. Kohn-Abrest, of Paris, will discuss "Dust and smoke," and Professor Lehmann, of Würzburg, "Gases." The subject of industrial lighting and eye-strain will be introduced by Dr. Gaster, of London; he will be followed by Dr. Oslath, of Trieste, who will deal with general physiopathology, and Dr. Stassen, of Liège, who will discuss light in mines. Reports on the value of fatigue tests will be made by Dr. F. Lee, of New York; Professor M. Patrizi, of Bologna, and Mr. Wyatt, of London.

THE *Archiv für Zellforschung*, founded and edited by Professor R. Goldschmidt, of Berlin, has suspended publication on account of difficulties with the publishers. It will be replaced by a new periodical—the *Zeitschrift für Zellen- und Gewebelehre*, edited by Dr. Goldschmidt and W. von Moellendorf, of Kiel, the first number of which has just appeared.

THE regents of the University of Colorado have changed the name of the Denison Laboratory for Medical Research, Boulder, to the Henry S. Denison Laboratory for Biological Research. The laboratory is the gift of Mrs. Henry S. Denison, of Denver, in memory of her son and husband. The removal of the medical school to Denver, next fall, is responsible for the change in name and purpose of the laboratory. Dr. Ross C. Whitman will remain in charge, but his title will be changed from professor of bacteriology to professor of pathology.

THE annual conference of the Universities of Great Britain and Ireland was held at the British Empire Exhibition, Wembley, on May 10. The morning session was devoted to discussion of the directions in which universities might profitably develop, at the present time, were funds available, and the Ph.D. degree as an encouragement to higher study and research. The subjects for the afternoon session were universities and research in relation to the development of the natural resources and the industries of the empire, and the interchange of university teachers and students within the empire.

THE American Society of Mechanical Engineers has available for loan a few manuscript copies of a "Bibliography on Measuring Instruments," prepared particularly from the viewpoint of the mechanical engineer, by F. S. Schlink, of the Special Research Committee on Permanency and Accuracy of Indication of Engineering Instruments. This bibliography seeks to cover only those fields not adequately taken care of in other reference sources.

PARIS correspondent of the *Journal* of the American Medical Association writes: "Last year Professor A. Calmette, of the Pasteur Institute, pointed out that the mortality from infectious diseases had diminished during the last thirty-five years. With preventive measures based on Pasteur's discoveries, we save an average of 90,000 lives a year. But if our public health services were properly organized and the mortality rate of France were brought down to that of Switzerland, the Netherlands, Denmark, Sweden and

Norway, we could save 180,000 lives every year, and with such saving the population of France would have remained around 40,000,000. However, since 1806—that is, since exact birth and death statistics have been kept—the birth rate has steadily declined. Recently, Calmette sent to the Academy of Medicine curves of the births and deaths during this period. These show that, during the first half of the last century, the number of births per thousand population was higher than the number of deaths. But, about 1855, the numbers begin to be more nearly equal. From 1890 on, the two curves begin to cross, and between 1914 and 1919 the births took a deplorable drop. Calmette estimates that the war not only cost France 1,500,000 lives, but prevented 1,560,000 births. A sudden upward trend of the birth curve in 1920 awakened hope, in which year the birth rate rose to 21.3 per thousand population in place of 9.5, which it was in 1916. But in 1921 it dropped back to 20.7 and in 1922 to 19.4. In the latter year, there was a deficit of 74,000 births as compared with 1920."

We learn from the London *Times* that recent acquisitions of the Natural History Museum at South Kensington include a skeleton of the dolphin *Pseudorca crassidens* from the Cambridgeshire Fens, presented by Dr. J. R. Garrood, of Huntingdon. The gift is of considerable scientific importance, as the type specimen of the species which belonged to the museum of the Stanford Institute was lost many years ago. Two meteoric stones, one weighing 2,869 grams and the other 1,355 grams, which fell at Merna, near Allahabad, were received from the director of the Geological Survey of India. A large collection of spiders made by the late Mr. H. R. Hogg was presented by his widow. This gift is of importance, as it includes the types of many Australian species described by Mr. Hogg. Professor A. Dendy, F.R.S., of King's College, London, presented the whole of his spirit collection of land planarians, comprising over 70 named species, a large proportion of which are types. This addition to the collection of a little-known group of worms is of much scientific interest. The purchases approved by the trustees included two specimens from Abyssinia of the Aard Vark in the flesh. These specimens are being dissected, and it is hoped that it may be possible from this material to throw some light on the problem of its proper place in the classification of the mammalia.

UNIVERSITY AND EDUCATIONAL NOTES

A BEQUEST of approximately $350,000 comes to the University of Wisconsin in a trust fund by the will of the late Thomas E. Brittingham.

PRINCETON UNIVERSITY receives $100,000 for the endowment of eight equal scholarships, four for Michigan and four for Maryland students, under the will of John G. Armstrong, of Detroit, Mich. The will directs that in choosing the holders of the scholarships "the general mental, moral and physical characteristics be taken into consideration rather than any specialized excellence in any one field."

DR. KENYON L. BUTTERFIELD has resigned the presidency of the Massachusetts Agricultural College to become president of the Michigan Agricultural College at Lansing, as successor to Dr. David Friday.

THE title of Mitchill professor of chemistry in Columbia University, previously held by Dr. Charles F. Chandler, who retired in 1910, has been conferred upon Dr. Henry C. Sherman, who has taught in the department of chemistry at Columbia continuously (except for absence on war service) since 1899 and has been executive officer of the department since 1920.

PROFESSOR ALBERT SAUVEUR, of the Harvard Engineering School, who is now on leave of absence abroad to receive the Bessemer Gold Medal, is named Gordon McKay professor of metallurgy and metallography. This professorship has been unfilled since 1917, Professor Edward D. Peters last holding it.

DR. LEO LOEB, director of the research laboratory at the Washington University School of Medicine, St. Louis, has been appointed Edward Mallinckrodt professor of pathology at the university.

AFTER sixteen years of service as head of the department of physics in Oberlin College, Professor S. R. Williams retires at the end of the present academic year to accept a position in Amherst College made vacant by the death of Professor A. L. Kimball.

VICTOR C. MYERS, Ph.D. (Yale), has resigned as professor and director of the department of biochemistry at the New York Post-Graduate Medical School and Hospital after thirteen years of service, and has accepted the appointment of professor of biochemistry at the State University of Iowa and pathological chemist to the University Hospital.

A NEW department of physiology and pharmacology has been organized at the University of Louisville with the following staff: Dr. Henry G. Barbour, professor of physiology and pharmacology; Dr. William F. Hamilton, assistant professor of physiology; Dr. Reinhard Beutner, assistant professor of pharmacology; Dr. Arville O. DeWeese, assistant professor of physiology and pharmacology, and Dr. Hulbert V. Noland, instructor in clinical pharmacology.

DR. RUDOLF KRAUS, who recently returned to Vienna after several years in charge of the State Serum Institute in Argentina and later in Brazil, has been appointed to the chair of pathology at the University of Vienna.

DISCUSSION AND CORRESPONDENCE

EFFECT OF DRY STORAGE ON THE ANTI-RACHITIC POTENCY OF COD LIVER OIL

IN recent experiments at this station a dry granulated mixture of starch (85 per cent.) and cod liver oil (15 per cent.)[1] which had been stored in corked bottles in the dark at about 50° F. for six months has been used as the sole source of the fat soluble and anti-rachitic substances in the diets of young chickens.[2] When cod liver oil in this form was given as one per cent. of the ration leg weakness (rickets) developed in all except one case (a total of twelve chickens) in from seventeen to twenty-three days. Control lots receiving raw cod liver oil (Harris) which had been stored under the same conditions and for the same length of time as the dry mixture, as .5 per cent., 1 per cent. and 2 per cent. of the ration (thirteen cases each), have made normal growth and have shown no symptoms of leg weakness through the seventh week.

Raw stored cod liver oil was found to effect a rapid cure of the leg weakness which developed in the lot receiving dry-stored cod liver oil, when given at the rate of two to three drops a day to chickens which had become prostrated but were still able to eat.

No symptoms of "vitamine A deficiency" as described by Emmet and Peacock[3] or Beach[4] were noted in the lot receiving dry-stored cod liver oil; although the evidences of deficiency of the antirachitic factor were unmistakable.

It is apparent, therefore, that the antirachitic potency of cod liver oil stored in a dry mixture as described above has been seriously impaired or destroyed.

L. C. DUNN

AGRICULTURAL EXPERIMENT STATION,
STORRS, CONNECTICUT

A NEW LOCALITY FOR A SPECIES OF DIAPTOMUS

THE entomostracan genus Diaptomus differs from many other entomostraca in that it has many somewhat localized species. While Cyclops has species cosmopolitan in their distribution the species of Diaptomus are frequently quite circumscribed in their habitats. The writer was therefore much interested when, while examining the copepod material collected by Dr. Fritz Johansen in connection with the Canadian Arctic Expedition of 1913–1918, *D. bacillifer* Kölbel was found in material collected at Bernard Harbor. As this was the first instance of the occurrence of an eastern continent Diaptomus in America, the literature on the species was examined with great care in order to make the identification positive. The result of the examination and a description of the species was published in the report on the Copepoda of the expedition, Part J, Vol. VII, of the general report.

Quoting from that report:

D. bacillifer has been found in Scotland, Norway, many places in the Alps, Asia Minor, Syria, the Caucasus, India, Central Asia, Siberia and in islands north of Siberia. It is a stenothermal cold-water form, and is found in the far north in bodies of water near the sea level, and farther south in lakes in the higher mountains.

In the collections of the Canadian Arctic Expedition it was found only in the gathering made on October 6, 1915, from a pond one foot deep a hundred feet above sea level on a ridge at Bernard Harbor. Some Diaptomi collected on St. Paul Island, Alaska, by Professor Parker, were sent to the author some time ago, and proved to be of this species. Apparently, then, it encircles the world in the general neighborhood of the Arctic circle, and probably will be found in many of the bodies of water in northern Canada. It seems strange that it has not appeared in the collections which have been made in Iceland and Greenland.

D. bacillifer has the distinction of having a wider distribution than any other species of the genus.

Recently I had occasion to look over the description of *D. arapahoensis* Dodd, published in the Proc. U. S. Nat. Museum, Vol. 49, pp. 99–101. I noticed the resemblance of my sketches of bacillifer to Dodd's figures of arapahoensis. A careful examination of his figures and the accompanying text leaves no doubt in my mind that they are identical. Dodd's description corresponds even in minute details to the description of bacillifer published in the Report of the Canadian Arctic Expedition. The only difference is in the segmentation of the female abdomen. Arapahoensis must be considered synonymous with bacillifer. Arapahoensis was found in lakes in Colorado at an altitude of about 11,000 feet. This makes a most interesting extension of the distribution of *D. bacillifer,* and it may be expected that further collection will show its presence in other localities of high altitude. Thus this species, found as stated before near the sea level in the Arctic, occurs also in the high mountains of Europe, Asia

[1] Prepared for us by The Harris Laboratories, Tuckahoe, N. Y.

[2] The basic ration used was: Pasteurized skim milk—ad lib; white corn meal, 97; calcium carbonate, 2; sodium chloride, 1; sifted pine sawdust (as roughage) 10 per cent. Hart, Halpin and Steenbock (*Jour. Biol. Chem.*, 52: 379–386) have found this ration to contain sufficient water soluble and antiscorbutic vitamines for growth in the chick. It is practically free from the fat soluble and antirachitic factors.

All chicks were reared from hatching time on a laboratory table which was rotated daily to insure equivalent lighting of all lots. All light falling on these chickens came through window glass.

[3] *Jour. Biol. Chem.*, 46: 679–693.

[4] SCIENCE, 58: 542.

and America, a remarkable distribution for a species of this genus.

C. DWIGHT MARSH

BUREAU OF ANIMAL INDUSTRY,
WASHINGTON, D. C.

THE USE OF A TOOL BY A SPHECID WASP

THE use of tools by sphecid wasps was first witnessed by the Peckhams and has since been reported by at least seven observers.[1] We wish to contribute one more record of this extraordinary behavior.

During the summer of 1922 we were collecting in open post oak woods near Bonham in northeastern Texas. Our attention, focused on a decaying stump, was suddenly distracted by a loud buzzing behind us. We turned to see a sphecid finishing her burrow by tamping down the filling with a pebble. The performance was not, however, being done according to Peckham. Our wasp pointed her abdomen directly upward and pounded with the tool held between her mandibles by moving her entire body up and down, thereby simulating a pile-driver rather than a hammer. As soon as she had finished we captured her. During the mêlée the pebble was lost; but it must have been about five millimeters in diameter, for the mandibles were spread to the limit while holding it. The burrow was then examined; the tamped filling was quite compact and remained intact when the surrounding soil was dug away. At the bottom of the burrow two inches below the surface there was a paralyzed caterpillar. The wasp was later determined by Mr. S. A. Rohwer as *Sphex* (=*Ammophila*) *gryphus* (Sm.).

GEORGE C. WHEELER
ESTHER HALL WHEELER

SYRACUSE UNIVERSITY

THE ADDRESSES OF AUTHORS

BECAUSE of the shortage of publication facilities, or perhaps more correctly, the increasing demand for publication facilities, there is a marked tendency at the present time toward brevity in the presentation of scientific matter in our professional journals. This is not wholly a bad tendency; in fact, many will strongly support the opposite contention, but at the same time the free exchange of ideas among scientific workers is the principal object sought in publication, and the restriction of this exchange is undoubtedly an obstacle to progress, even though it may be a necessity under present conditions. The liberal allotment of time for discussion of papers on our scientific programs is a recognition of the fact that much is to be learned from the author of a paper in addition to the material he has presented for publication.

The majority of papers published are not, however, presented before a scientific meeting but are sent direct to the editor by the author, and there is therefore no opportunity for discussion. The mails are available to fill this need, which leads me to the point I wish to make: Would it not be useful to scientific men if our professional journals were to publish in every case the addresses of their contributors along with their papers? I frequently have occasion to write to entomologists publishing in foreign journals, but am often unable to secure their addresses without first writing to the editor or to some leading foreign entomologist who may have their addresses. This is particularly true in case of the younger men who are not so well known. I am aware that addresses are often, perhaps generally, published, but my observation has been that this is done when the author has submitted it along with his paper and is not done if the author omits it. It has seemed to me that the adoption of a policy on the part of our editors of always publishing authors' addresses, or the name of the institution with which they are connected, would serve to make the desired free exchange of ideas more easily accomplished.

HARRY S. SMITH

UNIVERSITY OF CALIFORNIA

A CORRECTION

I NOTE upon page 444 of the May 16 issue of SCIENCE abstract of a paper submitted by me at the recent meeting of the National Academy of Sciences and entitled "Researches in the terephthalic acid group."

Through an unfortunate error, the name of my collaborator in this research, Dr. Philip S. Nisson, was in some way omitted in entering the item on the program of the academy, and I shall be glad to have you publish this brief note in SCIENCE calling attention to the fact.

MARSTON T. BOGERT

SCIENTIFIC BOOKS

The New Geology: A Text-book for Colleges, Normal Schools and Training Schools; and for the General Reader. By GEORGE MCCREADY PRICE. Pacific Press Publishing Association, Mountain View, California.

THIS good-looking book, embellished with excellent illustrations (of which more later), gives a first impression of actually being an orthodox and high-grade text-book of geology. A careful perusal of the work, however, leads to the conviction that the author, who is unknown to the membership list of the Geolog-

[1] See Wheeler, W. M.: "Social Life among the Insects," page 55.

ical Society of America and to the pages of Cattell's "American Men of Science," is a fundamentalist harboring a geological nightmare. In his own words, he has made his book "a travesty on the real science of geology," a science that has been built up through the labors of the geologists of the world during more than a century of observation, study and criticism. The things that have long been accepted as the fundamentals of this science—immensely long geologic time and an orderly development of organisms from single-celled individuals into the most complex community of cells as exemplified in mammals and man—are rejected by Price and in their place is substituted his "new catastrophism." This is our old friend, the "universal deluge," which Price says was brought about by a "jar or shock from the outside." All organisms were exterminated by it, including the "godless men" of the time, the only survivors being the God-fearing ones in the little ark that also harbored a loving pair of all living species of plants and animals, a million or more in number. Back of those preserved in the ark "there must have been a direct or literal creation of the originals from which the modern forms and the fossils were alike descended." The whole of the fossil worlds "lived contemporaneously," and the attempt to establish them in successive faunas led to a "paleontological whirligig [which] has been the leading diversion of people otherwise intelligent and scientific in their habits of thought."

So much for the "new" geology. I now come to a more serious matter. Before the publication of the book under review, its author wrote to Wiley and Sons, publishers of the copyrighted Pirsson-Schuchert "Text-book of Geology," asking for permission to use 32 of its illustrations. As this number was thought excessive, his request was refused, except in the case of three of the figures. Nevertheless, careful comparison of the illustrations in the two books shows that he actually appropriated 14 figures from Pirsson's "Physical Geology," and 18 from Schuchert's "Historical Geology"!

CHARLES SCHUCHERT

YALE UNIVERSITY

SPECIAL ARTICLES

THE ORIGIN OF ECTOPIC MENSTRUATING MULLERIAN TISSUE IN THE FEMALE PELVIS

A COMPLETE understanding of the origin of hemorrhagic cysts of the human ovary which contain or are lined by tissue of endometrial (Müllerian) type, is being arrived at by a steady accumulation of facts, and the substance of conclusions thus derived presents an entity of great interest to biologists in general as well as to the gynecologist and the pathologist.

Tissue of endometrial type and with the menstrual function has been observed in the human adult ovary as long ago as 1899. Such tissue until recently had been dismissed as derived either from *congenital* Müllerian rests or from the germinal epithelium through a process of metaplasia.

Sampson[1] in a series of classical studies has shown that endometrial or endosalpingeal epithelial cells cast loose at the time of menstruation or through trauma may be transported in the lumen of the oviduct to escape into the pelvis through the patent distal end of the oviduct. These cells may become implanted upon any of the pelvic structures and grow to "adenomata." And, what is of the greatest importance, all these multiple growths may be although not necessarily of the same age. Some cells attach themselves to the ovary, which becomes invaded in their proliferation, and closed spaces of Müllerian-like tissue result. Menstruation into these spaces may eventually lead to the formation of cysts which may reach fifteen centimeters in diameter. With thinning of the wall rupture may occur. When this happens there is further dissemination of epithelial seed (and possibly stroma cells) with further implantation upon many structures in the pelvis.

The writer,[2] working with rabbits seven to fourteen months old, has succeeded experimentally in producing widespread cystic growths in the pelvis by scattering promiscuously in the abdominal cavity scrapings and very finely divided bits of autologous endometrium. Some of the cysts formed come to contain blood as a result of the periodic oestrual cycles, but on account of various fundamental physiological differences between rabbit and man a well-developed hemorrhagic or "chocolate" cyst has not been attained. However, sufficient facts have been gathered by experimentation to render more secure Sampson's explanation of the genesis of ovarian hemorrhagic cysts and the frequently concomitant "adenomyomatous" reactions in the uterus, broad ligament and rectovaginal septum.

From a strictly biological point of view there is thus presented in women, most frequently between the ages of thirty and the menopause, an unique condition in which (a) normal endometrial tissue escaping through a natural opening in the oviduct into the pelvic cavity often becomes implanted on the ovaries and other pelvic structures; (b) these implants behave for a long time like normal endometrial tissue; (c) implants in the vicinity of smooth

[1] *Arch. Surg.*, 1921, iii, 245–323; *ibid.*, 1922, v, 217–280; *Boston Med. and Surg. Jour.*, 1922, clxxxvi, 445–456; *Amer. Jour. Obs. and Gyn.*, 1922, iv, 5.

[2] *Arch. Surg.*, 1922, v, 281–300; *Amer. Jour. Obs. and Gyn.*, 1923, vi, 257–262.

muscle often cause a myoplastic reaction on the part of said smooth muscle with a result that an "adenomyoma" is formed.

These ectopic endometrial growths offer themselves both before and after the menopause as foci for neoplasia. Sampson has been able to identify them as long as thirteen years after the natural menopause, although they undergo involution which, however, is similar to the histological changes present in the senile uterus. It has been shown by the writer that in rabbits the transplanted tissue persists at least five months following bilateral oöphorectomy and shows the same atrophy as the uterus.

Many of the cysts obtained in uncastrated animals are strikingly like the so-called multilocular cystadenoma of women, at least in most respects except size, and Dr. Sampson in a personal communication states that more careful examination of a series of cystadenocarcinomas of the human ovary has resulted in his finding at times small areas of apparently normal endometrial tissue in the lining of some loculi. A definite relationship between the implantation growths of Müllerian type and many of the papillary and cystic epithelial tumors of the ovary would seem to be an altogether reasonable and logical hypothesis.

While the clinical observations and the pathological and experimental studies would seem to satisfy all reasonable requirements in explaining the genesis of the menstruating cysts of the ovary and the more scattered implants, another theory for the origin of the primary ovarian lesion must be mentioned. This concerns the power of the germinal epithelium of the ovary postnatally to produce endometrial tissue. In the embryo the germinal epithelium gives rise to totipotential cells of the sex glands, but the application of this fact to the condition under discussion seems exceedingly farfetched, although it will probably always be utilized by those who find themselves unable to accept Sampson's conclusions.

Much argumentation would be obviated were it known conclusively that the germinal epithelium could give rise postnatally to ciliated epithelium. Since the endometrial cysts of the ovary are usually lined in part at least by ciliated epithelium (or to the same extent as is the uterine mucosa) and since, when rupture of such a cyst occurs, its lining may come into direct contact with the germinal epithelium in the process of healing, it becomes imperative more closely to examine any case where the peritoneum of the ovary is in continuity with ciliated cells. The writer as well as several other pathologists in large hospitals and a few biologists consulted have never seen what they could regard as an actual metaplasia of ovarian peritoneum into ciliated epithelium. Nevertheless, this change has been described by a few observers. Characteristic Müllerian stroma has not been noted as an accompaniment, however, and this is an important element in the production of the picture here described.

The strongest argument against a peritoneal origin for these menstruating "mülleriomas" is the fact that the ovary need not be involved at all in the primary dispersion of epithelium through the oviduct, but that there may be widespread "adenomata" of Müllerian type throughout the pelvis. It is not plausible to assume that this sudden crop of such growths is caused by a kaleidoscopic change in the pelvic peritoneum to ciliated epithelium with the simultaneous production of endometrial stroma.

The facts that this ectopic endometrial tissue may be found upon any pelvic structure, that it usually occurs in multiple foci, that the autotransplants have stroma typically endometrial in structure and function, and that they usually do not develop until the last fifteen years of menstrual life would seem to eliminate (a) the germinal epithelium of the ovary as their mother cells, and (b) the possibility of their being derived from *congenital* Müllerian rests rather than their being new growths acquired by implantation during the menstrual age of the individual.

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The electronic structure of organic compounds in relation to their heats of combustion: M. S. KHARASCH. Upon examination of the experimentally determined values of heats of combustion of organic compounds, certain remarkable relationships can be traced between the electronic structure of the compounds and their total energy values. If we ascribe the heat liberated in the combustion of methane to the displacement of the electrons between the carbon and oxygen atoms, then the molar heat of combustion of methane would be X times 8, if X is the amount of heat liberated by the displacement of an electron between the carbon and oxygen atoms.

The electric moments of typical organic molecules: CHARLES P. SMYTH. The electric moments of typical organic molecules calculated from the dielectric constants, together with other experimental data, are smaller than those obtained from theories of molecular structure because of the displacement of electrons within the molecules, the magnitude of the difference depending largely upon the mobility of the electrons. The moments of a number of alcohols are compared with those of water and the ethers. These values, which should agree if there were no distortion of the molecular symmetry, show that the groups attached to the oxygen repel each other, the amount of repulsion varying with their bulk

and altering the moment. The principal doublet in a molecule induces secondary doublets in the rest of the molecule so that the moment of the whole tends to increase with increasing size of the molecule. Moments calculated for a large number of hydro-carbons, aldehydes, ketones, amines and halides resemble in their behavior those of the alcohols and ethers.

A study of ionization produced in gaseous reactions: A. K. BREWER and FARRINGTON DANIELS. Ionization has been detected in every gaseous reaction which has been investigated. The apparatus permits the measurement of currents small as 10^{-15} amperes at temperatures up to red heat, with a potential gradient as high as 2,700 volts per cm. The reactions studied include the oxidation of nitric oxide with oxygen and with ozone, and the decomposition of ozone, of nitrogen dioxide and of nitrogen pentoxide. In every case the ionization is proportional to the voltage and to the number of reacting molecules. The currents are very small, only one pair of ions reaching the electrodes for approximately 10^{13} molecules, which react.

Antagonistic actions of radiations of different frequency: S. E. SHEPPARD. A brief history is given of the observations, commencing with Ritter, of opposing effects with different rays. New experimental material is presented, showing effects of this character occurring entirely within the ultra-violet region of the spectrum. The early relation of the conception of antagonism to that of polarity in the theory of chemical affinity is noted, and its later development into the radiation hypothesis of chemical reaction. The limits of utility in guiding experimental work are discussed.

On tertiary X-radiation: GEORGE L. CLARK. When primary X-rays fall upon a secondary radiator there are produced scattered rays with the same wave-lengths as those characteristic of the target; fluorescent rays characteristic of the elements in the radiator; and tertiary rays produced by the impact upon neighboring atoms of secondary photo-electrons, which are completely ejected from atoms by the primary rays. Tertiary rays appear as bands in the spectrum with the short wave-length limit defined by the equation $\lambda = \lambda, \lambda^2/\lambda^2-\lambda^1$, where λ^1 is a primary wave-length and λ^2 is the critical absorption wave-length of the radiator element. Experiments with tungsten primary rays and secondary radiators with atomic numbers 6 to 60, and with molybdenum primary rays and secondary radiators with atomic numbers 3 to 17 confirm the above tertiary ray mechanism rather than the shift in wave-lengths predicted by the quantum theories of Compton, Debye and Jauncey or the theory of D. L. Webster that the tertiary rays are produced by the impact of electrons in the same atom.

The temperature-entropy diagram for nitrogen: W. H. RODEBUSH and J. B. TAYLOR. By performing a Joule Thomson experiment on liquid nitrogen at a given temperature and pressure, the heat content of the liquid can be calculated from the percentage vaporized after the expansion. The heat contents of liquid nitrogen have been determined from the boiling point to the critical temperature. The entropy of the liquid is readily calculated and the entropy of the vapor can be calculated from existing data. Since heat losses can be minimized at low temperatures it is believed that the diagram obtained for nitrogen is the most accurate that has been obtained for any liquid. Some interesting conclusions can be drawn as to the temperature range over which a liquid may be used as a refrigerant.

Negative catalysis and chain reactions: HANS L. J. BÄCK STRÖM. Certain of the photochemical reactions that are known to be chain reactions are also known to show the phenomenon of negative catalysis. Examples are the hydrogen-chlorine combination and the photo-decomposition of hydrogen peroxide. Christiansen has recently advanced the idea that some thermal reactions may also be chain reactions and that this may explain the fact that they can be negatively catalysed by small amounts of certain substances. To test this idea the autoxidation of benzaldehyde has been studied. The photochemical reaction has been shown to be a chain reaction and it has been found that, in general, substances that inhibit the photo-reaction also inhibit the thermal reaction and vice versa. It seems likely, therefore, that this is a case of a thermal chain reaction. Other reactions are being studied.

The point of minimum catalytic activity: F. O. RICE and MILTON BERGSTEIN. Karlsson has measured the rate of hydrolysis of acetic acid esters in buffer solutions and has found that a point of minimum catalytic activity occurs near $pH = 5$; this is not in agreement with the results of Wijs, who studied the autocatalytic hydrolysis of methyl acetate in pure water; Wijs obtained a minimum rate at 10^{-6} N acid concentration and by assuming (1) that the total hydrogen ion and the total hydroxy ion are catalytically active and (2) that the ratio of the activities of hydroxyl and hydrogen ions is 1400/1 he calculates K for water to be 2×10^{-14}. We may, however, assume that only the unhydrated ions are catalytically active, that their activity is approximately equal and that at $pH = 5$ the concentration of dry hydrogen ion equals the concentration of dry hydroxyl ion. Support for this second view is obtained by observations on a number of different reactions which all have a point of minimum catalytic activity at $pH = 5$.

The temperature coefficients of chemical reactions: F. O. RICE and CHARLES F. FRYLING. On the basis of some considerations recently put forward it has been predicted that chemical reactions will fall into comparatively few classes; this can be illustrated by the acid hydrolysis of fatty acid esters, their halogen derivatives, the cyano-esters and hydroxy esters, all of which have a temperature coefficient $k_{35}/k_{25} = 2.4$ (approximately). Any reaction catalysed by a strong acid and which is not hydrolytic in character should have $K^{35}/k^{25} = 3.01816$. This has now been confirmed for a number of reactions between ketones and halogens in dilute solution which have widely different velocities but identical temperature coefficients.

Carbon monoxide as a poison in the ethylene-hydrogen combination in presence of metallic copper: ROBERT N. PEASE and LELAND A. STEWART. Previous measurements have shown that carbon monoxide is much more

strongly adsorbed by catalytic copper than either ethylene or hydrogen, indicating that it should act as a poison in the ethylene-hydrogen combination. Experiments have shown that this is the case. The efficacy of the carbon monoxide is of another order than was to be expected from the adsorption measurements, however. Thus, it was found that a sample of copper which would adsorb at a few mms pressure approximately 1 cc of either ethylene or hydrogen or 5 cc of carbon monoxide was deprived of 90 per cent. of its activity by so little as 0.05 cc of carbon monoxide. The activity could be restored merely by pumping out at 250°. This result seems to indicate that only a small fraction (1 per cent.) of the catalyst surface which is active in adsorption is also active in catalysis. This is in agreement with previous results in the poisoning of copper by mercury and the deactivation of copper by heating.

Metallic calcium as a hydrogenation catalyst: ROBERT N. PEASE and LELAND A. STEWART. Considerations as to the preferential adsorption of hydrogen by hydrogenation catalysts, such as copper and nickel, lead to the prediction that the metals which form hydrides should be good hydrogenation catalysts. This has been verified for metallic calcium using the ethylene-hydrogen combination as a typical hydrogenation reaction. Rapid reaction occurs at 200°. Calcium takes up hydrogen as fast as let into the bulb at this temperature, the total volume of hydrogen corresponding approximately to the dihydride. In the presence of ethylene, however, the hydrogen goes almost entirely to form ethane, as shown by analysis. Ethylene is also slowly taken up by the hydrogenated calcium, a part being at the same time converted to ethane. The absorbed ethylene is not given off at 300° and does not markedly affect the catalytic activity of the preparation. Evidence of solution of hydrogen in calcium hydride was obtained.

Equilibrium in the vapor phase between ethyl alcohol, ether and water: ROBERT N. PEASE and CHI CHAO. YUNG. Previous measurements on the kinetics of the catalytic dehydration of ethyl alcohol to give ether and water in the vapor phase in presence of alumina having indicated an approach to a state of equilibrium at 275° and 300° corresponding to about 65 per cent. (mol) conversion of the alcohol, further measurements have been carried out to fix more precisely the position of equilibrium. The results show that equilibrium corresponds to the conversion of 62.0 per cent. (mol) of alcohol at 275°. Measurements were also carried out at 130°, using concentrated sulphuric acid as catalyst, which gave 86.5 per cent. (mol) as the maximum conversion at that temperature. The above figures correspond to equilibrium constants of 0.665 and 10.27, respectively. The latter in turn give 8,290 cal. as the average heat of reaction, which is to be compared with 6,700 cals. calculated from thermal data.

Heats of fusion of trinitrotoluene, tetryl and picric acid: C. A. TAYLOR, WM. H. RINKENBACH and R. E. HALL. Data obtained in determining the freezing point curves for the binary systems of TNT-Tetryl, TNT-Picric Acid and Tetryl-Picric acid were used in calculating the heats of fusion of the compounds. The heat of fusion in gram calories per gram of substance obtained were: TNT, 20.73; Picric Acid, 19.46; Tetryl, 20.58.

The specific heats of trinitrotoluene, tetryl, picric acid and their molecular complexes: C. A. TAYLOR and WM. H. RINKENBACH. The specific heats were determined by means of the liquid oxygen calorimeter first described by Dewar. Small masses of the material being tested are dropped into liquid oxygen and the oxygen volatilized by the heat liberated by the mass is measured. The specific heat of lead has been accurately determined, so lead was used as a standard and determinations were made alternately with lead and the compound being tested. Check determinations were made on naphthalene whose specific heat is known. The specific heat of TNT, tetryl, picric acid and their molecular complexes was calculated for 10 degree intervals from 0° C. to their melting points.

Irregularities in the specific heats of liquids: J. W. WILLIAMS and FARRINGTON DANIELS. Temperature-specific curves have been determined for 15 organic liquids. Of this number benzene, ethyl benzene and carbon tetrachloride exhibited irregularities which have been studied further. The irregularities indicate a transition from one molecular species to another. No corresponding irregularities could be found in the vapor pressures or in the densities. It is likely that specific heat measurements offer the best means for determining different molecular species in liquids.

Vapor pressure of liquid ammonia: ALFRED T. LARSON and CHARLES A. BLACK. The ammonia content of the gas phase for the system NH_3 (liquid) — NH_3 (gas—$(3H_2 + N_2)$ has been determined for total pressures ranging from 50 to 1,000 atmospheres, and temperatures ranging from + 18°C. to—22° C. The deviation of the apparent vapor pressure of ammonia from that calculated for an ideal gas increases with both the temperature and the pressure in this system. No data are at present available which make it possible to predict the extent to which the vapor pressure of ammonia would be increased in this compressed liquid-gas system.

The fugacity of hydrogen and hydrogen ion at pressures to 1,000 atmospheres: D. A. MACINNES, W. R. HAINSWORTH and H. J. ROWLEY. The measurements of the effect of hydrogen pressure on the electromotive force of the cell:

$$H^2 \mid HCl\ (0.1\,N),\ Hg\ Cl \mid Hg,$$

previously reported to 400 atmospheres, have been carried to 1,000 atmospheres with improved apparatus and increased accuracy. At the highest pressure the fugacity has been found to be over 100 per cent. higher than the corresponding gaseous pressure. Of this difference between fugacity and pressure about three fourths are due to the departure of hydrogen from the perfect gas laws and one fourth is due to a decreased activity of the hydrogen ion, due presumably to the solubility of the hydrogen.

A study of the liquid junction potential between hydrochloric acid and saturated potassium chloride by means of the flowing junction: GEORGE SCATCHARD. A report of measurements of the electromotive force of the

cells: Pt, H^2 | HCl (c), AgCl | Ag and Hg | HgCl, KCl (sat) | "HCl (c), AgCl | Ag (^{a} = flowing junction), with (c) varying between 0.01 M and 1.5 M. The potentials are reproducible to within 0.1 millivolt. The first cell measures the mean activity of hydrogen and chloride ions; the second, the activity of the chloride ion assuming that the liquid junction potential is constant. This assumption is concordant with the MacInnes assumptions of individual ion activities between 0.01 M and 0.1 M, but becomes increasingly discordant with increasing concentrations. In no part of the range is it concordant with the assumption that the activities of the hydrogen and chloride ions are equal.

Grain growth in 99 per cent. lead 1 per cent. antimony alloys: R. S. DEAN and W. F. HUDSON. The relation of time and temperature of annealing and degree of deformation to the grain size 99 per cent. lead–1 per cent. antimony alloy has been studied. From the results some conclusions are drawn concerning the mechanism of grain growth.

Reactions in phosgene solution. III. Reactions with metallic oxides, sulfides and carbonates: ALBERT F. O. GERMANN. It has been shown in previous papers that, while pure phosgene does not react with metals except at high temperatures, when it is largely dissociated into chlorine, liquid phosgene containing dissolved aluminium chloride reacts readily with certain metals, the rate of the reaction depending in part on the solubility in phosgene of the chlor-aluminate formed, and in part on the thermal effect. Chauvenet and others have shown that metallic sulfides and oxides will react with phosgene vapor at high temperatures; Nuricsan showed that cadmium sulfide will react with phosgene above 270° C. Liquid phosgene at 20° C. reacts extremely slowly with cadmium sulfide. Phosgene containing dissolved aluminium chloride reacts rapidly with cadmium sulfide, yielding carbon oxysulfide and a slightly soluble cadmium compound, the composition of which has not yet been determined. Magnesium oxide and carbonate react rapidly with liquid phosgene containing dissolved aluminium chloride, yielding carbon dioxide in each case, and calcium and magnesium chloraluminate, respectively.

Further studies on the luminescence of Grignard compounds: W. V. EVANS and EDW. DIEPENHORST. In order to investigate the intensity and wave length of the light given out when aromatic Grignard compounds are oxidized we have made a great many of these compounds in fourteen different solvents. We have discovered that all the aromatic Grignard compounds we have been able to produce give this luminescence on oxidation, provided the magnesium is attached to a carbon in the benzene ring. The intensity of the luminescence when the same compound is produced in different solvents depends on the physical properties of the solvent. We have also investigated: (1) The effect of another group in the ring on this luminescence. (2) The effect of the position of this group or groups on the luminescence. (3) The occurrence of this phenomenon among the derivatives of anthracene and naphthalene. At present we are engaged in attempting to secure spectrographs of this light.

The luminous efficiency of the glow of phosphorus: ELLIOT Q. ADAMS. The efficiency of light production by chemical reactions proceeding at ordinary temperatures appears not to have been measured hitherto. Such a measurement in the case of phosphorus was made by saturating a stream of specially purified (atmospheric) nitrogen with phosphorus by bubbling through saturated solutions of phosphorus in refined cottonseed oil, with finely divided phosphorus in suspension, and allowing the saturated gas to escape into the air. The intensity of the "flame" was matched by illuminating an annulus of filter paper with a flashlight bulb, sliding on a vertical rod. Approximate color match was secured by a suitable green light filter. The data of Centnerszwer on the vapor pressure of phosphorus, together with the heat of combustion of phosphorus and the rate of flow of nitrogen, gave the energy input. The rate of light production to energy input was found to be slightly less than one lumen per kilowatt, and not to differ materially at 25° and at 40°. The work is being continued and extended to other photogenic reactions.

The use of subscript and superscript exponents in mathematics and in chemistry: ELLIOT Q. ADAMS. Subscripts and superscripts are used in logic, in algebra and in higher mathematics in a manner consistent enough to permit the generalization that subscripts are used to designate the various members of a series or group of related symbols, while superscripts denote the same operation as would be represented by the repetition of the symbol to which the exponent belongs, a number of times indicated by the exponent. It would conduce to clearness of thought and ease of expression to preserve this distinction in the notations of arithmetic and of chemistry. In arithmetic the value of a given digit depends on its position relative to units place, the possible values of the digit forming an infinite geometric series of numbers, the ratio between successive terms being ten. To designate a particular value of a digit, the principle stated above calls for a subscript indicative of its position in that series. The logical starting point is units place, *e. g.* $3^0 = 3$, $6^3 = 6000$, $c = 2_{10}9986$, $h = 6_{-27}554$. In chemical symbols the suggested use of sub- and superscripts would give: $H^2O = HHO$, and would make Li_6 and Li_7 represent two different atomic species of the element lithium, the subscripts being in this case the atomic weights of the two known isotopes of lithium.

Note on the efficiency of photosynthesis by Chlorella: ELLIOT Q. ADAMS. The efficiency of photosynthesis by *Chlorella* has been found by O. Warburg and E. Negelein from 33.8 per cent. with blue light to 59 per cent. with red; in one experiment 63.5 per cent. calculated from the heat of formation of glucose 674 Kal/mol. The heat of the reaction: $CO_2 \times 3H_2O = 2H_2O_2 + HCHO$ (aqueous sol.) is —171 Kal/mol. The energy of two mol quanta each at 0.666 and 0.640μ (absorption max. for a– and b–chlorophyll) is 175 Kal. Since 6 mols HCHO are required to form 1 mol glucose, the max. efficiency to be expected is $674/(6 \times 175) = 64.2$ per cent.

A spectrophotometric study of colored halite: T. E. PHIPPS and WALLACE R. BRODE. Stassfurt blue halite and

halite colored artificially with sodium or potassium vapor were studied by means of a spectrophotometer and an auxiliary electric furnace, over wide ranges of temperature. The Stassfurt blue halite showed a slight absorption in the green and a deep absorption in the red. The latter band shifted with rising temperature towards the yellow, until, in the neighborhood of 589μ (temperature 250° C), the color faded completely. The artificially colored halite showed a sharp absorption band at 589μ (purple colored crystal), or near 556μ (pink colored crystal). The color in all cases varied widely with different heat treatments of the crystal, but faded to a light yellow color in the temperature range 600-650° C.

Studies in photographic sensitivity. V. Action of arsenites and oxidizing agents on sensitivity: E. P. Wightman, A. P. H. Trivelli and S. E. Sheppard. Experiments with solutions of arsenites containing various quantities of soda were made to test Clark's theory of the action of such solution on the photographic plate. The results of these experiments are somewhat in disagreement with his and certain of his conclusions appear incorrect. He states that there is no interaction between monosodium arsenite and silver bromide. We have obtained strong evidence that there is some action. At least the bromide is slightly soluble in the arsenite solution, and on addition of developers, silver can be precipitated from the solution. With the higher sodium arsenites solutions saturated with silver bromide, a *spontaneous* decomposition occurs with deposition of silver. Our experiments indicate that the action of arsenite in producing developability is partly to dissolve the silver bromide grains; the silver arsenite, complex in the solution or adsorbed then decomposed depositing silver, probably on the preexistent sensitive nuclei. The reason for reversal with excessive treatment may be due simply to increasing amounts of sodium bromide being formed and adsorbed to the sensitive spots, thus lessening developability.

Adsorption of iodine by phosphorus and charcoal: John Krants and Neil E. Gordon. The adsorption of iodine by phosphorus from various organic liquids was determined for different concentrations of the iodine and at different temperatures. Both the concentration and the temperature had marked effects on the adsorption of the iodine. Results were compared with other investigators where charcoal was used in place of phosphorus. The results were figured out molecularly and it was found that where no chemical action took place between the solvent and iodine the adsorption was the greatest from the liquid in which the iodine was the least soluble.

The adsorption of mercuric sulfide by chromium hydroxide: Harry N. Holmes and M. A. Dietrich. In the hydrogen sulfide group HgS will not be precipitated if the ratio of chromium to mercury is too high. When mercury is in excess the chromium may be dragged down with the HgS. This mutual adsorption explains a peculiar difficulty with the NaOH–Na_2S reagent. When the sulfides of Group II are heated with this reagent chromium sometimes appears as chromium hydroxide peptized by the alkali. The test for mercury often fails due to the fact that this colloidal chromium hydroxide adsorbs the mercuric sulfide and carries it into suspension. This trouble does not occur with fresh solutions of chromium salts. Nor will it occur if an old solution is boiled with considerable HCl. This indicates the slow hydrolysis of chromium salt solutions. There is never any difficulty with solutions of chromium sulfate and curiously enough, this solution yields practically no colloidal chromium hydroxide on hot dialysis. The complex ion effect enters here.

Adsorption of precipitates VII. The coagulation of sols by electrolytes in the presence of non-electrolytes: Harry B. Weiser and Charlotte M. Schaler. The influence of non-electrolytes on the critical coagulation concentration of electrolytes is determined by the effect of adsorption of the non-electrolyte in question (1) on the adsorption of the ions present in the sol and (2) on the adsorption of the precipitating and stabilizing ions of the electrolyte added to effect precipitation. Depending on the conditions, therefore, the precipitation value of an electrolyte may be raised, lowered or remain unchanged in the presence of a non-electrolyte. The conclusions have been reached from a study of adsorption during the precipitation of both positive and negative sols.

The use of motion pictures in the study of Brownian movement and protective action of hydrophilic colloids: Wesley G. France. Preliminary report. Suspensions of basic lead carbonate electrolytically precipitated in the presence of gelatin and containing particles varying in size from 0.2 to 2.0 microns, diameter, were microphotographed at a magnification of 1,000 to 1,500 diameters with a motion picture camera. The negatives thus obtained were then projected on a calibrated screen such that a total magnification of from 50,000 to 200,000 diameters was attained. Measurements of the magnitudes of the Brownian movements of the various sized particles were then made and compared with those of similar sized particles prepared in the absence of any protecting colloid. Some microphotographs were also made of the Brownian movements in gold sols observed with the ultra-microscope.

A simple kinetic principle underlying colloid phenomena: Jerome Alexander. Specific surface is compared with kinetic motion, a catch-all factor. In the colloidal zone these balance; on approaching true solution kinetic motion becomes excessive; in coarser subdivisions both decrease. Therefore, with increasing dispersion colloidal characteristics rise to a maximum and then fall off. This accounts for zone of maximum colloidality.

Colloidal suspensions in phosphorus: Claude Haines Hall, Jr. The author has continued his previous work on colloidal suspensions in phosphorus (black phosphorus) by means of a modified apparatus and has prepared suspensions of various degrees of density of mercury, lead and other metals. Many properties of these suspensions are described. Thénard's work has been repeated and confirmed as well as the conclusions of the previous paper.

Graham Edgar,
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(To be continued)